SECTION 99

PROPULSION CONTROL, AND ALARM AND MONITORING SYSTEMS

99.1 REFERENCES

(99A) **VOLUME V,** *OWNER - FURNISHED EQUIPMENT*

(99B) IEEE Std 45, *Recommended Practice for Electric Installations on Shipboard*

(99C) IEEE Std 518, *Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources*

(99D) Code of Federal Regulations - 46 CFR Sub-chapter J

99.2 INTRODUCTION

This Section contains the Contractor Design and Provide general requirements applicable to installation of the Owner - Furnished Equipment (OFE) Propulsion System Integration (PSI) Contractor Propulsion Control System, and Alarm and Monitoring System, and is supplemented by the requirements specified in other Sections of the Technical Specification.

For WSF Fleet-wide Standardization purposes, End No. 1 of the Vessel shall always be considered the bow, and this designation shall delineate port and starboard, fore and aft wherever they are addressed in the Technical Specification.

99.3 GENERAL

The OFE PSI Contractor Propulsion Control System, and Alarm and Monitoring System will be designed, assembled, installed, tested and certified in accordance with this Section, the PSI Contractor's Bid Support Documentation, Reference (99A), and Authoritative Agencies requirements. The Vessel shall be delivered with the machinery plant Propulsion Control and Alarm and Monitoring Systems installation fully approved and certified by the USCG. The machinery plant control and monitoring system requirements stated in this Section and throughout these WSF Requirements are not an interpretation of the aforementioned Authoritative Agencies rules and regulations, but are, for the most part, a combination of supplemental WSF requirements and clarifications thereof.

The requirements of ASTM F1166, shall be observed when incorporating human engineering criteria into the design of the control stations, consoles and the machinery plant control and monitoring systems.

The equipment and installations covered in this Section of the Technical Specification shall be in accordance with the requirements of Reference (99B), as well as the rules and regulations listed elsewhere.

The OFE Propulsion Control System as set forth under Reference (99A) and all Contractor provided support as set forth in this Section and other Sections of the Technical Specification, shall be suitable for use in a marine environment – that is, resistant to salt air and moisture-laden atmospheres, and not affected by shipboard vibration, motions, ambient temperatures and power source variations. Refer to the referenced Authoritative Agencies for specific environmental design criteria.

The Contractor's provided components for the OFE Alarm and Monitoring System shall be fully supportable by the system manufacturer for a period of no less than fifteen (15) years from the date of Vessel delivery.

The Contractor shall install the OFE Alarm and Monitoring System described herein.

The Contractor shall have demonstrated a successful installation and service history on a USCG/ABS inspected Vessel, and the installation shall be in conformance with the proven performance criteria of Section 50 of the Technical Specification. The "basic" OFE Alarm and Monitoring System will be approved and certified by the USCG.

99.4 DESIGN AND INSTALLATION REQUIREMENTS

The machinery plant shall be remotely controlled and monitored, to the extent required by Authoritative Agencies and these WSF requirements, from the following three (3) stations:

1. No. 1 Pilothouse
2. No. 2 Pilothouse
3. Engineers Operating Station (EOS)

The Primary control station (EOS Control Console) will be OFE PSI Contractor equipment with a system of indicators, alarms, displays and controls that:

A. Provides for the effective operation and monitoring of the propulsion machinery and its ancillary equipment, Ship's Service and Emergency Diesel Generator sets as set forth in Section 88 of the Technical Specification, and auxiliary Ship's Service systems and equipment under all modes of operation;

B. Shall be monitored by and/or require the action of the Watch Engineer;

C. Enhances personnel safety; and,

D. Provides for the safe operation of the machinery plant.

Secondary control stations (Pilothouse Control Consoles) shall be designed and provided by the Contractor and be kept as simple as possible and provided with only those indicators, displays, alarms and controls that:

A. Provide for the effective operation of the Propulsion Engines, controllable-pitch propellers;

B. Shall be monitored by and/or require the action of the Deck Officer;

C. Enhance Crew member and Passenger safety; and,

D. Provide for the safe operation of the Vessel.

All Contractor provided equipment and machinery equipped with remote control and monitoring systems shall also have provisions for local manual control and monitoring. Local instrumentation shall be in accordance with this Section and Section 85 of the Technical Specification.

Both OFE Propulsion Control, and Alarm and Monitoring Systems will be of a fail-safe design – that is, a design that, upon failure or malfunction of a component, subsystem or system, automatically reverts to a predetermined design state of least critical consequence.

The Emergency Power supply for the machinery plant control and monitoring system shall provide an uninterrupted source of power. Refer to Section 96 of the Technical Specification for system requirements.

The OFE EOS Control Console will include remote switchboard controls and instrumentation.

Control consoles shall not contain fluid tubing for instrumentation.

Console mounted controls, instrumentation and alarms shall be from the same manufacturer to the extent practicable and shall be aesthetically similar in appearance. However, when controls, instrumentation and alarms to be installed in any given console are provided by two or more vendors (whether such items are furnished loose by the factory or in factory designed and tested subpanels), the Contractor shall provide guidance to the vendors regarding the provision of such items (gage size, display type, manufacturer, etc.), in order to maximize commonality of components and ensure an aesthetically similar appearance.

The OFE Propulsion Control, and Alarm and Monitoring System installations shall have separate low level signal and control cables from electromagnetic interference by isolating such cables in separate cableways in accordance with the requirements of Reference (99C). Installation drawings developed by the Contractor and manufacturer(s) of the machinery plant control and monitoring system shall identify each cable's wiring level and class in accordance with Reference (99C).

The OFE Propulsion Control, and Alarm and Monitoring Systems installations shall be installed to provide at least a 20-percent (20%) reserved expansion capability for additional displays, switches, indicators and alarms to accommodate post delivery machinery plant upgrades. Where modular assemblies of individual switches, indicators and alarms are provided, the reserved space allocated for future expansion shall include the module's internals with lens covers.

Cableways and multi-cable transits (MCT/MCP) at bulkhead and console boundaries shall be as set forth in Section 87 of the Technical Specification.

For cable installation, identification, and termination, see Section 87 of the Technical Specification.

The OFE Propulsion Control, and Alarm and Monitoring Systems will be equipped with built-in test and self-diagnostic functions. Component failures within these functions shall not result in any degradation of the machinery plant control and monitoring system.

99.5 PROPULSION CONTROL

99.5.1 General Requirements

The Contractor shall provide for, as part of his bid, coordination services, schedule, material, and support of all major component factory trained technical representatives for all factory, SSDG Contractors, and all OFE Contractors required set up, light off, adjustment, and testing of all OFE PSI Contractor equipment. Assume 120 days, **after** all shipyard provided equipment and material is installed, operational, satisfactorily tested, and approved by the WSF Representative, for set up, light off, and adjustment testing for each Vessel. All system coordination services shall be identified and scheduled as part of the *Master Construction Schedule (MCS)* Subsection in Section 100 of the Technical Specification.

99.5.2 Control Consoles

The EOS Control Console will be furnished as Owner - Furnished Equipment (OFE), and shall be modified, by the Contractor, for all Contractor provided equipment as set forth in the Technical Specification, while the Pilothouse Control Consoles shall be designed and provided by the Contractor. The Contractor's Pilothouse Control Console design shall incorporate the OFE PSI Contractor's control console components set forth in Reference (99A).

The Contractor shall provide **all** foundations and brackets necessary and as required for mounting **all** control consoles and **all** equipment associated with the Propulsion Control System. Provide all external interconnecting cables to the designated enclosures. The PSI Contractor will terminate all interconnecting cables inside enclosures as set forth in the PSI Contractor's Bid Support Documentation. Cables for the Pilothouse Control Consoles shall be bottom entry. Cables for the EOS Control Console shall be top entry. Provide and terminate all motor control and indicator circuit cables in accordance with WSF approved Contractor motor control wiring diagrams for those motors shown to have remote control and indicating functions located at a control console.

The Pilothouse Control Consoles shall be constructed of unitized aluminum, steel or brushed stainless steel. The consoles shall be free-standing and rigidly constructed with all internal stiffeners and supports. Aluminum or steel construction shall have exterior surfaces painted with a polyurethane electrostatic powder coating finish of a color approved by the WSF Representative, minimum five (5) mils thick. Prior to coating, the metal shall be prepped with a phosphate wash. Stainless steel construction shall not be painted, but shall have the exterior surfaces brushed to provide a mat finish. The console external surfaces shall have fully radiused edges and corners. Provide Teak wood trim on the Pilothouse Control Consoles similar to WSF ISSAQUAH Class Control Consoles. Sand the wood smooth, seal and finish with two (2) coats of a high quality, satin finish, exterior grade marine spar varnish. Varnish shall be applied in strict accordance with manufacturer's recommendations. Between the first and second coats, sand the varnish smooth.

The Contractor shall build full size plywood or aluminum honeycomb sheeting mock-ups of a Pilothouse Control Console and those portions of the EOS Control Console accepting Contractor provided equipment, based on the WSF approved Contractor's control console construction drawings. The console mock-ups shall include layouts of instrumentation and controls, handrails and access panels. All console mounted components shall either be installed or replicated in wood or heavy cardboard to give a detailed representation of the actual completed console. The console's internal stiffeners and supports shall be located to identify possible interferences with mounted controls and instrumentation. General areas for locating the control console's internally mounted components (i.e., terminal boards, control and monitoring modules, etc.) shall be identified to confirm accessibility for maintenance and troubleshooting. Illustrative drawings showing alternative configurations of each console shall be submitted for WSF review and comment prior to fabricating the full scale mock-ups. The control console mock-ups shall be available for WSF inspection for a minimum of fourteen (14) days. The WSF proposed alterations shall be demonstrated by incorporation into the console mock-ups before the console design and construction Working Drawings are prepared.

All electrical wiring shall be designed to be neatly arranged, secured and led to clearly marked terminal strips mounted to backing plates located inside the panel. The terminal strips shall include sufficient connection points for all reserved equipment installations and expansion requirements. The terminals shall be of the proper size and type for the electrical signal or power terminated. Terminal strips and console components shall be clearly labeled and coded to correspond with the control and monitoring system electrical schematics. No cable shall be run directly to the final panel mounted device.

Control console top openings, cutouts and penetrations shall be laid out and made prior to applying the electrostatic powder coat, unless stainless steel is used in the console construction. Make all signal, power and control wiring connections for all console mounted devices. Propulsion components shall be wired in accordance with WSF approved PSI Contractor working drawings. All other console mounted equipment shall be wired in accordance with WSF approved Contractor Working Drawings.

The arrangement of console instrumentation and controls shall be symmetrical, except where asymmetric features are selected by the WSF Representative during design reviews and mock-up demonstrations. The arrangements shall also be functional and aesthetically pleasing.

99.5.2.1 Pilothouse Control Consoles

The Pilothouse Control Consoles shall be arranged for standing operators, with its height limited to allow full vision over the consoles.

The Contractor shall provide installation of those equipment, as set forth in specific Sections of the Technical Specification, and as requiring installation within the Pilothouse Control Consoles.

Provide a full-sized AutoCAD® Format Mock-Up of a Pilothouse Control Console face panels accurately depicting all proposed equipment installation and cable installation. This full-sized Mock-Up shall be provided to the WSF Representative for guidance and approval prior to fabrication and installation begins. The WSF Representative shall have final authority as to OFE PSI Contractor and Contractor equipment locations. No equipment installed by the PSI Contractor, as delivered to the Shipyard, shall be relocated within the console without ***prior*** written approval of the WSF Representative.

99.5.2.2 EOS Control Console

The OFE EOS Control Console will have space for additional equipment required to be provided by the Contractor.

The Contractor shall provide installation of those equipment, as set forth in specific Sections of the Technical Specification, as requiring installation within the OFE EOS Control Console.

The Contractor shall provide equipment pushbuttons in the OFE EOS Control Console, as set forth in **TABLE 99-1** below. Pushbuttons shall be laid out in a logical manner as approved by the WSF Representative.

TABLE 99-1
EOS Consoles Pushbuttons

END No. 2 CONTROLS		END No. 1 CONTROLS
CPP Servo Pump No 3		CPP Servo Pump No 1
CPP Servo Pump No 4		CPP Servo Pump No 2
CPP Drain Pump No 3		CPP Drain Pump No 1
CPP Drain Pump No 4		CPP Drain Pump No 2
CPP Hub Pump No 2		CPP Hub Pump No 1
Stern Tube Pump No 3		Stern Tube Pump No 1
Stern Tube Pump No 4		Stern Tube Pump No 2

TABLE 99-1, cont'd EOS Consoles Pushbuttons		
END No. 2 CONTROLS		**END No. 1 CONTROLS**
Electric Reduction Gear Pump No 2		Electric Reduction Gear Pump No 1
Fire Pump No 2		Fire Pump No 1
Bilge Pump No 2		Bilge Pump No 1
Auxiliary Cooling Pump No 3		Auxiliary Cooling Pump No 1
Auxiliary Cooling Pump No 4		Auxiliary Cooling Pump No 2
Fuel Oil Transfer Pump		Sewage Transfer Pump No 1
Fuel Oil Purifier		Sewage Transfer Pump No 2
Potable Water Pump No 1		Sewage Lift Station Pump
Potable Water Pump No 2		Fresh Water Back-flush Pump
Hot Water Heating Circulating Pump No 1		Sewage Tank Exhaust Fan No 1
Hot Water Heating Circulating Pump No 2		Sewage Tank Exhaust Fan No 2
Hot Potable Water Circulating Pump		Sewage Aeration Blower No 1
Oil-fired Hot Water Heater		Sewage Aeration Blower No 2
Air Compressor No 1		Graywater Lift Station
Air Compressor No 2		EOS Air Conditioning Air Handler
EOS In Port AC Cooling Pump		EOS Air Conditioning Compressor
Steering Gear No 3		EOS Control Flat Exhaust Fan
Steering Gear No 4		Steering Gear No 1
PH2 Air Conditioning Air Handler		Steering Gear No 2
PH2 Air Conditioning Compressor		PH1 Air Conditioning Air Handler

TABLE 99-1, cont'd EOS Consoles Pushbuttons ##		
END No. 2 CONTROLS		**END No. 1 CONTROLS**
Crews Quarters Air Conditioning Air Handler		PH1 Air Conditioning Compressor
Crews Quarters Air Conditioning Compressor		Officers Quarters Air Conditioning Air Handler
Crews Quarters Exhaust Fan		Officers Quarters Air Conditioning Compressor
Passenger Lounge No 2 Air Handler		Passenger Lounge No 1 Air Handler
Passenger Lounge No 2 Return Air Fan		Passenger Lounge No 1 Return Air Fan
Steering Gear No 2 Supply Fan		Steering Gear No 1 Supply Fan
Void No 2 Supply Fan		Void No 1 Supply Fan
Tank Room No 2 Supply Fan		Tank Room No 1 Supply Fan
Tank Room No 2 Exhaust Fan		Tank Room No 1 Exhaust Fan
Reduction Gear Room No 2 Supply Fan		Reduction Gear Room No 1 Supply Fan
Reduction Gear Room No 2 Exhaust Fan		Reduction Gear Room No 1 Exhaust Fan
Sun Deck No 2 End Exhaust Fan		Inner Bottom Void Supply Fan
Engine Room No 2 Supply Air Fan		Passenger Deck Restroom Exhaust
Engine Room No 2 Exhaust Air Fan		Sun Deck No 1 End Exhaust Fan
Spare		Engine Room No 1 Supply Air Fan
Spare		Engine Room No 1 Exhaust Air Fan
Spare		Spare

TABLE 99-1, cont'd EOS Consoles Pushbuttons ##		
END No. 2 CONTROLS		**END No. 1 CONTROLS**
Spare		Spare
Spare		Spare
		Spare
		Spare
## Provide SQUARE D, XB5 Series (22mm) illuminated pushbuttons		

The Contractor shall provide REDLION Model C48T digital LED Dual Preset Hour Meters, one (1) for each Main Engine on the EOS Console. Locate in accordance with the direction of the WSF Representative.

Provide a full-sized AutoCAD® Format Mock-Up of the EOS Control Console face panels accurately depicting all proposed equipment installation and cable installation. This full-sized Mock-Up shall be provided to the WSF Representative for guidance and approval prior to fabrication and installation begins. The WSF Representative shall have final authority as to Contractor equipment locations. No equipment installed by the PSI Contractor, as delivered to the Shipyard, shall be relocated within the console without ***prior*** written approval of the WSF Representative.

Any equipment found to not fit into that space available for additional equipment in the console, shall be provided with cabinets and installed within the EOS, as approved by the WSF Representative.

CAUTION: ***The Contractor shall exercise extreme caution during equipment installations to prevent damage to the OFE EOS Control Console and equipment therein. The Contractor shall provide extraordinary measures to protect the console finish and all existing and installed equipment in the console from the effects of physical damage, dirt, grime, and metal flakes falling on and into other equipment in the console. Any damage caused by such harm and/or contamination shall be at the sole expense and schedule of the Contractor.***

99.5.3 Control Systems

The OFE PSI Contractor's Centralized Propulsion Control System will be a microprocessor(s) based system having redundancy and fail-safe capabilities.

99.6 ALARM AND MONITORING

Provide installation of the OFE PSI Contractor supplied Alarm and Monitoring System as set forth in this Section and Reference (99A). The system installation shall be suitable for use in a marine environment – that is, resistant to salt air and moisture-laden atmospheres, and not affected by shipboard vibration, motions, ambient temperatures and power source variations. Refer to the referenced Authoritative Agencies for specific environmental design criteria.

99.6.1 Monitoring System

The OFE PSI Contractor machinery plant monitoring system will be a microprocessor(s) based system having redundancy and fail-safe capabilities.

99.7 SPARE PARTS AND INSTRUCTION MANUALS

Provide a list of recommended spare parts and special tools for those items which are Contractor furnished, together with parts lists and instruction manuals necessary to maintain and service provided equipment and accessories in accordance with the requirements of Sections 86 and 100 of the Technical Specification.

99.8 TESTS, TRIALS, AND INSPECTIONS

Tests and trials shall be in accordance with this Section and Section 101 of the Technical Specification.

Inspections shall be performed as defined in this Section and Section 1 of the Technical Specification.

99.9 PHASE II TECHNICAL PROPOSAL REQUIREMENTS

The following deliverables, in addition to others required by Section 100 and the Technical Specification and the Authoritative Agencies, shall be provided, for all Contractor provided equipment, during the Phase II Technical Proposal stage of Work in accordance with the requirements of Section 100 of the Technical Specification:

A. Machinery Plant Instrumentation List

B. Machinery Plant Safety Controls List

C. Machinery Plant Controls List

D. Pilothouse Control Console Equipment Installation Study

E. EOS Control Console Contractor Equipment Installation Study

The ***Machinery Plant Instrumentation List*** shall include all Contractor provided console mounted alarms, indicators, and displays. The list shall include the size of displays and whether the instrumentation is flat panel display and/or analog based.

The ***Machinery Plant Safety Controls List*** shall include all Contractor provided safety trips, interlocks and manual overrides of, all Contractor provided equipment, in concert with the PSI Contractor's provided machinery plant's equipment and related control systems. The list shall include set points for all safety trips and interlocks.

The ***Machinery Plant Controls List*** shall include, all Contractor provided equipment, in concert with the PSI Contractor provided local and remote machinery plant controls.

The ***Pilothouse Control Console Contractor Arrangement & Details Study*** shall include layouts of **all** equipment to be installed in the console as set forth in this Section and other Sections of the Technical Specification.

The ***EOS Control Console Contractor Equipment Installation Arrangement & Details Study*** shall include layouts of all Contractor provided and installed equipment associated with the OFE EOS Control Console which are to be installed in the console as set forth in this Section and other Sections of the Technical Specification.

The Contractor shall plan on direct participation from the WSF Representative in developing the Pilothouse Control Console layout drawings.

See Section 100 of the Technical Specification for additional requirements regarding technical documentation.

99.10 PHASE III DETAIL DESIGN AND CONSTRUCTION REQUIREMENTS

The following deliverables, in addition to others required by Section 100 of the Technical Specification and the Authoritative Agencies, shall be submitted during the Phase III Detail Design stage of the Work in accordance with the requirements of Section 100 of the Technical Specification:

A. Pilothouse Control Console Layout Mock-Up Artwork

B. EOS Control Console Contractor Equipment Installation Layout Mock-Up Artwork

C. EOS Control Console Flat Panel Screen Display Diagrams

D. Machinery Plant Control and Monitoring System Color Code Scheme
E. Qualitative Failure Analysis, (PSI Contractor)
F. Design Verification Test Procedure, (PSI Contractor)
G. Periodic Safety Test Procedure, (PSI Contractor)
H. Machinery Plant Instrument List, (PSI Contractor)
I. Regulatory Approval / Certification Letters
J. Environmental Qualifications Letters

The ***Pilothouse Control Console Layout Mock-Up Artwork*** shall include accurately represented, full-size layouts of **all** equipment to be installed on or in the console as set forth in this Section and other Sections of the Technical Specification.

The ***EOS Control Console Contractor Equipment Installation Arrangement & Details Study*** shall include accurately represented, full-size layouts of all Contractor provided and installed equipment associated with the OFE EOS Control Console which are to be installed on or in the console as set forth in this Section and other Sections of the Technical Specification.

A PSI Contractor prepared ***Qualitative Failure Analysis*** shall address PSI Contractor provided propulsion controls, microprocessor-based system hardware, safety controls and interlocks, electric power management and any other automation to ensure the safety and reliability of the design. The analysis shall be conducted to a level of detail necessary to demonstrate compliance with all requirements. The analysis shall include assumptions, operating conditions considered, failure modes, cause and effect relationships, how failures are detected by the crew and corrective measures available to the crew.

A PSI Contractor prepared ***Design Verification Test Procedure*** shall provide the subject procedures for all PSI Contractor provided automatic and remotely controlled or monitored vital systems. The test procedure shall be based on the Qualitative Failure Analysis and shall verify that all automated vital systems are designed, constructed and operate in accordance with WSF and Authoritative Agencies requirements. ***This document shall not be a substitute for the installation test procedure required by Section 101 of the Technical Specification.***

A PSI Contractor prepared ***Periodic Safety Test Procedure*** will be assembled by the WSF Vessel staff. The Contractor shall provide WSF the subject procedures data for all Contractor provided equipment to periodically demonstrate to Authoritative Agencies the proper operation of the Contractor provided primary and alternate controls, alarms, power sources, transfer override arrangements, interlocks, and safety controls to allow for assembly of the procedure by WSF. ***This document shall not be a substitute for the Installation Test Procedure required by Section 101 of the Technical Specification.***

A PSI Contractor prepared ***Machinery Plant Instrumentation List*** shall include all Contractor provided local and remote machinery plant alarms, indicators, and displays. The list shall include the display's size, scale range and alarm set points. The Contractor shall provide information, in a format compatible to the PSI Contractors list, for all Contractor provided instrumentation in a timely basis to allow for PSI Contractor inclusion in their Machinery Plant Instrumentation List**.**

The ***Regulatory Approval / Certification Letters*** will document approval of, all Contractor provided equipment, in concert with the PSI Contractor's proposed OFE Alarm and Monitoring system.

The ***Environmental Qualification Letters*** shall document and certify environmental qualifications of, all Contractor provided equipment, in concert with primary system components for ship motions and vibration, voltage and frequency tolerances, temperature operating range, and shipboard atmospheres proposed by the PSI Contractor.

The ***Pilothouse Control Consoles - Arrangement & Details*** shall present accurately represented and located, to scale layouts of fabrication of the console along with **all** equipment to be installed on and in each control console, as set forth in this Section and other Sections of the Technical Specification. Final arrangement and design of consoles shall be subject to approval by the WSF Representative.

The ***EOS Control Console Electrical Equipment Installation - Arrangement &Details*** shall present accurately represented and located, to scale layout of all Contractor and OFE PSI Contractor equipment to be installed on and in the console, as set forth in this Section and other Sections of the Technical Specification. Contractor provided equipment to be installed into the OFE EOS Control Console shall include, but not be limited to, AMS alarm points, Hi-Fog Water Mist Fire Suppression System control panel, Rudder Angle Indicators, Steering Control & Alarm panel, Sound Powered Telephone No. 3, Hands-off Talk Back Intercom, Engineer's Call Circuit, "FR" circuits rotary switches, Vent System control panel, Clock, CCTV system monitors/controls, WTD Mimic Panel, and Security System monitors/controls. Final arrangement and installation design of Contractor installed equipment on and in the console shall be subject to approval by the WSF Representative.

See Section 100 of the Technical Specification for additional requirements regarding technical documentation.

(END OF SECTION)